Statement of Research Contribution

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One of the major discoveries at RHIC has been the formation of a strongly interacting medium with partonic degrees of freedom in ultra-relativistic heavy ion collisions. Electromagnetic radiation, i.e., photons and lepton pairs, are penetrating probes that allow investigating the full time evolution and dynamics of the matter produced, as they do not undergo strong interaction in the final state.

The dilepton continuum provides insight into a variety of interesting fundamental physics topics: the low mass continuum allows studying the possible modification of vector mesons due to chiral symmetry restoration. The intermediate mass region gives access to the open and bound charm and bottom states which complements the heavy flavor measurements via semi-leptonic decays and direct reconstruction of charm and bottom mesons. Furthermore, the very low mass region, below twice the pion mass, can be used to extract a signal from internal conversions of virtual direct photons. Direct thermal photons will provide information about the initial temperature of the hot and dense medium created in heavy ion collisions as well as information about the evolution of the system through the various phases of partonic and hadronic matter.

In my thesis, I present the first measurement of electron-positron pairs from p+p collisions at $\sqrt{s}$ = 200 GeV collected during the RHIC run in 2005 and compare them to results from Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV taken in 2004 with the PHENIX detector. One important part of my work was the development of techniques to properly subtract the various combinatorial and correlated backgrounds of e^+e^- pairs. This background arises from false combinations of electrons and positrons from different origins, which is an inevitable and large contribution to the dielectron spectrum, as the sources of electrons are a priori unknown. The invariant mass distribution of e^+e^- pairs in p+p collisions is consistent with the expected contributions from Dalitz decays of light hadrons, dielectron decays of vector mesons and correlated charm production, which have been measured in the same experiment. The charm and bottom cross section extracted from the measured dielectron yield are $\sigma_{cc} = 544 \pm 39$(stat.) $\pm$ 142(syst.) $\pm$ 200(model) μb and $\sigma_{bb} = 3.9 \pm 2.4$(stat.) $^{+3}{}_{-2}$ (syst.) μb, respectively. The dielectron continuum measurement in p+p provides a crucial baseline for the modification of the dielectron continuum observed in Au+Au. In min. bias Au+Au collisions the yield of dielectrons in the low mass region ($150 < m_{ee} < 750$ MeV/c^2) is enhanced by a factor of 4.0 $\pm$ 0.3(stat.) $\pm$ 1.5(syst.) $\pm$ 0.8(model) compared to the known hadronic sources. The centrality dependence of this enhancement suggests emission from in-medium scattering processes. The excess dominates the yield in the transverse momentum region below 1 GeV/c and shows significantly lower $\langle p_T \rangle$ than the expected sources. The low p_T enhancement is currently not understood by any theoretical model of heavy ion collisions. The enhancement extends to larger transverse momenta (p_T > 1 GeV/c) where it is also observed in p+p and explained by virtual direct photons. The p+p measurement serves as an important test to pQCD calculations of direct photon production from hard scattering processes in this momentum range. An excess with an inverse slope of T_{eff} = 221 $\pm$ 23(stat.) $\pm$ 18(syst.) MeV is observed in central Au+Au collisions above the binary scaled direct photon yield in p+p. This can be qualitatively explained by hydrodynamical models including thermal photon radiation with initial temperatures of $300 \le T_{init} \le 600$ MeV and formation times of $0.12 \le \tau_0 \le 0.6$ fm/c.

The result of my thesis on the dielectron continuum in p+p collisions has been published by PHENIX in Phys. Lett. B **670**, 313 (2009). Furthermore, my work has made important contributions to the PHENIX papers arXiv:0706.3034 and arXiv:0804.4168.